

## TORREYA

July, 1903

## A NEW AND CHEAP FORM OF AUXANOMETER

BY F. E. LLOYD

It is very much more interesting and instructive, in elementary courses in botany, to observe periodicity of growth in plants than merely to demonstrate, by means of a lever, what every one knows already, namely, that plants grow. It is sounder pedagogically to do such experiments quantitatively, since, when so performed, they mean very much more in training. It is for this reason that attempts have been made to construct a cheap form of auxanometer by attaching a recording cylinder to the minute-hand spindle of an ordinary clock. It is obvious, however, that the centering of a cylinder, and its vertical adjustment without lateral movement, are by no means easy of accomplishment. A cylinder is very likely to revolve irregularly unless made with very great care, a process which involves turning and centering on a lathe, and skilful mechanical adjustment to the clock. I have to confess to failure in this direction, except after a too great expenditure of time and labor. Happily, however, this experience has led me to devise a very cheap and accurate mechanism which accomplishes the end desired, and this at a very small cost of money, time or skill. This is done by substituting for a revolving cylinder, a lever, which is jogged once an hour by an arm moved by the minute-spindle of a seventy-five cent clock.

As will be seen by the illustration, the lever bearing the record is fixed on a horizontal axis, and stands vertically upwards, held against a block by means of a thread, reeved through a wire pulley, drawn sufficiently taut by means of an attached weight. This weight must be heavy enough to draw back the record

[Vol. 3, No. 6, of TORREYA, comprising pages 83-96, was issued June 12, 1903.]

lever to the block when it has been displaced from the vertical, say from 0.5 to 1.5 cm., according to the length of the lever and of the record. The arrangement of thread and weight was chosen because, with a little adjustment, the lever may thereby be pulled back quietly and quickly without shock or vibration, after it has been moved by the minute-spindle arm. To set up such an apparatus one may proceed as follows: Take a box, a wooden packing- or mailing-box of suitable size, say approximately a cube, 15–20 cm. on a side, fill it with gravel and nail it up. This makes a good, solid stand. Its solidity is enhanced by gluing on the under side as feet, three bits of thin cork. Upon

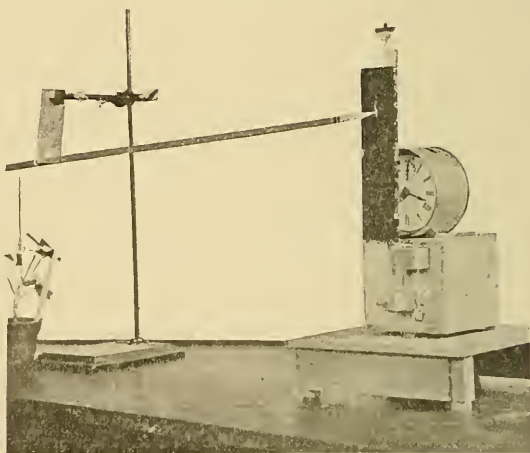


FIG. 1.

the top of this stand is affixed a cheap clock from which the glass face has been removed. Its minute-hand must be suitably bent in an L, or in its place an L-shaped arm affixed to the spindle, so that during its rotation, it will move against a shoulder or pin on the record lever. This lever is a wooden arm on an axis attached to the side of the stand below the clock. A little care must be given to adjusting the axis—a wire nail serves very well—so as to avoid any lateral shake. The shoulder or pin upon which the minute-spindle arm plays should be arranged so that the record lever will be moved but a little distance, and then be released. It will then be drawn quickly

back to its vertical resting position against the wooden block. It is plain that the recording point of the auxanometric lever itself, which is attached to a growing plant, will make a horizontal mark, if allowed to drag across a sheet fixed to the lever arm, or exactly speaking, an arc of a large circle. Since the end of the lever, attached to the plant, is constantly falling as the plant grows, it is obvious that the distance between these marks, which will be made at hourly intervals, will show a record of the growth, amplified of course, in the ratio of the lever arms. The chief difficulty, and this is but a slight one, is in getting the planes of the two levers sufficiently parallel, so that the record-

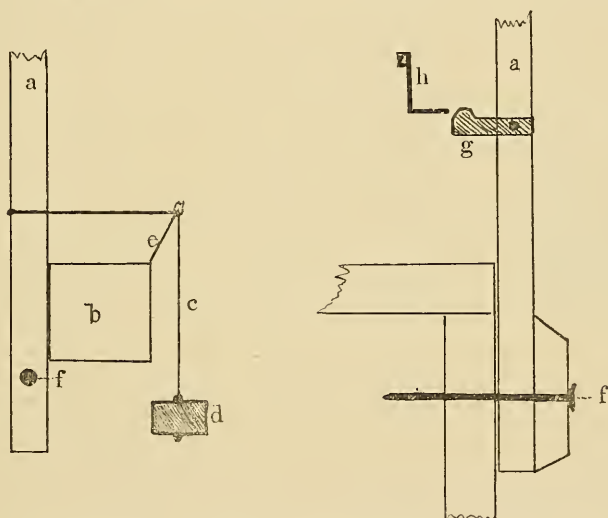


FIG. 2. Sketch to show details of lever-mechanism. *a*, lever, carrying record; *b*, wooden block; *c*, thread, to which is attached weight, *d*, and which moves through bent wire pulley, *e*; *f*, pivot; *g*, shoulder on which the arm attached to minute-hand spindle, *h*, impinges; if the latter is bent once more at right angles, the shoulder, *g*, need be but a simple pin. The arm, *h*, is displaced to one side to make the drawing clearer.

ing point will work freely and at the same time not swing away from the surface on which the record is to be made. When this trifling obstacle has been overcome, one has a piece of apparatus which will give a beautifully exact and clear record of hour intervals of growth. It will readily be seen that half-hour intervals may be obtained by having a double arm or by placing two

shoulders or pins on the record lever in the proper positions. Such brief intervals are, however, hardly useful except in special cases.

The auxanometric lever should work easily and smoothly, and truly in a vertical plane. This may be accomplished in a manner devised by Professor Herbert M. Richards, who kindly allows me to incorporate the idea in this paper. A U-shaped piece of metal is cut out, and the ends of the legs are bent to a J-form. These serve as beds for pieces of capillary, or very heavy-walled, glass tubing which function as "hole-jewels" for the pivot of the recording lever. This pivot may be made of a thinnish needle, preferably a long one. Placing the "hole jewels" on the pivot, they are bedded into the J-shaped arms by means of shellac or, better, sealing-wax, and adjusted so as to give as little end-shake to the lever as will allow it to work freely. The lever and its support are then a simple piece of apparatus which may be held in place by means of a clamp. The clamp may be easily improvised, a gravel-filled box or bottle serving as a foot, or a retort stand may be used.

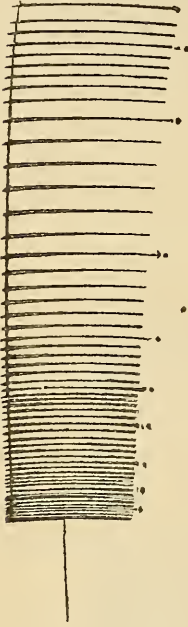


FIG. 3. Record of growth of *Vicia Faba* seedling. The dots opposite the marks indicate six-hour intervals, beginning at 6 P. M., May 14, 1903. The decrease and irregularity in growth after the first 24 hours was due to unfavorable conditions.

The recording pen is very satisfactory if made of sheet celluloid, which may be appropriately bent so as to scratch lightly on smoked paper or mica, attached to the lever actuated by the arm on the clock.

Mica is especially good because it does not warp if carefully smoked and may be used in making sun-prints. The record reproduced in the accompanying figure was made in such a way. Some pieces of bent tin serve to make a holder for the recording surface or it may be attached simply by thumb tacks.